[*With Compliments.*

ON SOME OF THE PATHOLOGICAL AND PHYSIOLOGICAL RELATIONS OF BRAIN, MIND, AND HIGHER NERVE FUNCTION: BEING THE ADDRESS DELIVERED AT THE BEGINNING OF THE SESSION OF THE PATHOLOGICAL AND CLINICAL SOCIETY OF GLASGOW.

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Gentlemen,—The nature and faculties of mind, and the union it has with living body, constitute a problem that has exercised the powers of not a few of the greatest intellects in all ages. Until the present generation, the study of mental phenomena was prosecuted under many disadvantages. The anatomy and physiology, both human and comparative, of the central nervous system, were so little advanced that it was hopeless to obtain light from these sources. The facts of insanity were also imperfectly known, and its invariable association with disease of the brain had yet to be discovered; the bearing of mental unsoundness on the problem was therefore not realised. Further, many of the dialects of language were either unknown, or had not been studied, and consequently could not yield those indications of mental development which are now derived from their analysis. In fact, those engaged in such studies were

under the neeessity of resting their eonelusions mainly on the revelations of their own eonsciousness. Systems of psyehology so eonstrueted eould not fail to be defeetive, at least, as eomplete expositions of mind in all its relations. But while coneurring with a reeent distinguished writer on mental physiology (Dr. Maudsley), in regarding *introspection* as only one of several means of investigation now within our power, it seems to me that in his estimate of the labours of metaphysicians in the past, he has not made suffieient aeknowledgment of the baekward state of the scienees to whieh I have referred. Now, however, that these seienees have of late years attained so great a development, no writer on psyehology ean afford to ignore the testimony they bear. This is at present being fully appreciated by metaphysieians themselves, as is well shown by a reeent work that has emanated from Edinburgh University.

Moreover, in their enthusiasm for anatomical, physiologieal, and pathologieal methods, Maudsley, and other writers of the school to whieh he belongs, have shown too great a disposition to overlook or undervalue the signifieanee of faets which are not revealed to us by any of these methods: I refer to sueh conceptions as the existence of the Deity, and to the aspirations after immortality. The belief in a Deity, however degraded the eoneeption of Him, and the aspirations after immortality, are, as Dr. Tylor shows, to be found wherever man dwells, and are far too universal to be aeeounted for by contact with civilisation, as some allege they may be explained. These are faets as real as those we aseertain by the sealpel, the mieroseope, or the erucible, and ought to be taken into aecount and duly weighed in every system of mental philosophy.

Passing now from preliminary eonsiderations, we proceed to the diseussion of those questions which form the speeial subject of this address. Though their pathological aspeet, as is fitting here, will oeeupy a large share of our attention, it will tend to their better elucidation, and will altogether be most appropriate to have regard, in the first instanee, to their anatomieal and physiological relations. This leads me at the outset to remind you of a few general facts respeeting the arehiteeture of the nervous system.

The most simple form of a nervous apparatus, in the mueh referred to aseidian, for example, is two sets of fibres meeting at a centre, the ganglion. The one fibre is afferent, the other efferent, and the ganglion reeeives the impression and emits foree. This, as you well know, is reflex aetion in its simplest form, at least as effected by a distinct nervous mechanism. How wide now is the applieation of the theory of this mode of

action—a theory which, when submitted to the Royal Society, was regarded as of so little moment that, it is stated, the paper in which it was explained and supported was declined by that learned body as unworthy of a place in its proceedings. At present, however, the theory is held in such esteem that it is not only generally admitted as the explanation of many of the phenomena of animal life, but, in an expanded form, is regarded by disciples of the Somatic school—those who hold that "the bodily organism embraces the whole nature of man" —as also sufficient to account for the loftiest productions of the human mind.*

As we ascend the scale of life, up to and inclusive of man himself, the simple mechanism we have explained becomes gradually more complex, but the same type is maintained more or less in all. Series of such combinations of ganglionic centres and nerve trunks compose the longitudinal cord of the articulata, each ganglion presiding independently, to a large extent, over the segment with which it is connected, but at the same time associated with those above and below by communicating fibres. In the higher grades, the greater specialisation implies an increase of ganglia and additional central connections, and so on with ever increasing complexity. It is to be observed that, along with the increase and differentiation of organs and their ganglia, there is more complete integration; that is, there is not simply a repetition of similar segments, each of which, as in the worm, is almost capable of separate existence; on the contrary, organs are mutually dependent, and the functions of the whole organism are required for the proper life of the individual.

In man the spinal cord is homologous with the central nervous system of the articulata. There are parts in it of corresponding power or authority, so to speak, connected with each other by communicating fibres, and connected also with higher ganglia in the brain by other fibres which pass directly to them from below. The lower centres are co-ordinated with the nervous mechanism of other organs in these upper ganglia, and in this way, besides greater control of the functions of inferior centres by the higher, and the possibility of greater unity of action, there is the capacity of greater specialisation of movements. The general plan of construction of the brain itself is in harmony with the belief that there are in it arrangements for successive

* It is, however, to be observed that Marshall Hall's theory is by no means universally accepted. The late Mr. Lewes rejected it—at least in the ordinarily received form.

integrations and differentiations of function between the cord and the convolutions, in the great ganglionic masses that intervene—particularly those of the medulla and pons, the ganglia in or near the lateral ventricles, and those in the cortical grey matter itself.

This doctrine of increasing specialisation, associated with integration, to be seen in the progression from inferior to upper ganglia, attaining its highest degree of completeness in the supreme centres of all—the hemispherical ganglia, has important bearings on the prevailing views respecting the localisation of function in the convolutions. It has been fully expounded in Herbert Spenser's work on Psychology; but more definitely, in relation to Pathology, by Hughlings Jackson. The following is Dr. Jackson's brief statement of the theory:—"The conclusion," he remarks, "I have arrived at from the study of cases of disease is, that the higher centres are evolved out of the lower, receiving intercalations as they ascend from the spinal cord to the cerebrum. The higher centre re-represents *more especially* the impressions and movements already represented, *generally* in the one below it. The co-ordinations are continually being re-co-ordinated; for example, those of the pons and medulla are re-co-ordinated in the cerebrum. There are, in the lower centres, sensori-motor processes for very *general* purposes, but in *their* higher representatives for the more special. A rude symbolisation would be to suppose the pons varolii to represent the simple sensori-motor processes of the cord raised to the fifth power, and the cerebral hemispheres, these processes, suddenly raised again, let us say, to the fiftieth power."

The short account we have given of the general plan of construction of the central nervous system may suffice to show that even in the highest centres of all there may be localisation of function. Spenser's and Jackson's views must still, however, be considered speculative to a large extent; but they are in accordance with the known anatomy of the brain, and are also consistent with such physiological facts as the powers manifested by acephalous infants, and by animals at different levels of the vertebrate series, and also with the results of destruction, ablation, and electrisation experiments on the brain.

We now proceed to consider at some length this theory of localisation of function, and particularly as it relates to the cerebral convolutions. Though we cannot here enter into it at all fully, it will be our endeavour to point out its present position in physiology; how far it seems worthy of acceptance, and how far it must still be considered problematical. At the

outset reference will be made to the subject of aphasia. It merits this position, both because it gave us the first distinct illustration of cortical localisation, and also as we probably owe to the interest awakened by the remarkable phenomena of that condition not a few of our recent advances in cerebral physiology and pathology.

Passing over the earlier history of aphasia, I shall first advert to the theory of its pathology advanced by myself. In the end of 1865, having certain typical cases of the disease under my care, I gave a good deal of attention to the aphasic state. The results of my observations were submitted to the Medico-Chirurgical Society of this city, early in 1866. Impressed with the correctness of the views held by Max Müller and others that thought, in the sense of reasoning, is impossible without language in one form or another, and having clearly proved that thought in that sense was undoubtedly present in the minds of some aphasics, I sought to explain the absence of language on the theory that there was a lesion of the highest conductors necessary for the articulation of words. It was contended that there were definite conducting fibres between the convolutions and the corpus striatum or other subordinate co-ordinating centres for the different forms of language: one set for vocal speech; another for writing; and another for gestures: which were destroyed or damaged; and it was further held that these conducting fibres had *determinate* positions in the cerebrum.

After the lapse of these years, and the observation of many more cases of aphasia, I still hold that there must be words in the minds of such patients as show that they are capable of reasoning, though it is admitted that the mental powers are generally weaker than they appear to ordinary observers. I now think that words in aphasics who can reason, enter into consciousness as revived impressions which arise at the auditory or visual perceptive centres. Words so arising are probably rarely perceived with that clearness which they have when distinctly completed (even though not articulated) at the outgoing part of the cortex; and consequently the reasoning process is somewhat imperfect, is proportionately obscure. Though there can be little doubt that the lesion in most cases is in the cortex, whereby the power of developing motor intuitions for words is lost, I still adhere to the view that in patients who are speechless or nearly so, but who can write their thoughts, or express them well by gestures, the structural defect may be one of motor conductors for articulation: at all events, this is quite sufficient to account for the condition.

I have said that these conductors were regarded by me as having definite points of connection with the surface of the brain and lower ganglia. This, it will be observed, is cerebral localisation. Dr. Ferrier thinks so. His remark is "a differentiation of numerous distinct physical paths, which is but another aspect of localisation after all." It was a pretty obvious corollary (not, however, made by me), that if there were separate motor conductors for the movements of the tongue in speech, or for the hands in writing or gesture, there would be efferent fibres for other movements as well; and, further, that what was true for the outgoing impulses in motion, might probably also be valid for incoming impressions in sensation—that there would be distinct pathways for its different forms, both special and general; and that, therefore, there would be definite parts of the surface with which they were connected. Dr. Charlton Bastian, in quoting, in 1869, these views of mine with approbation, remarks that I had not further developed my theory.*

But though the idea of localisation is involved in this theory of special conductors for combined movements, the merit of having first distinctly propounded the proposition that there are definite motor centres for associated movements in the convolutions belongs to Hughlings Jackson. It is now a matter of history how Dr. Jackson's conclusions, based on the observation of disease, were supported by the discovery, in 1870, by Fritsch and Hitzig, that certain portions of the brain's surface were sensitive to electricity; and how their statements were afterwards confirmed, but at the same time modified by the valuable observations of Ferrier in this country, and by many others. Dr. Ferrier claims to have also indicated, by his experiments, the seat in the convolutions of the centres for the special senses, as well as that for general sensation. A large amount of evidence bearing on the question has now been accumulated, and it will be my endeavour to place the main facts before you, in as condensed a form as possible, with the inferences that seem fairly deducible from them. These facts are of three kinds—namely, physiological, pathological, and anatomical, which we will consider in their order.†

* I may mention that indifferent health in 1867, and for some years afterwards, compelled me to relinquish these studies.

† I was not aware, till after this paper was for the most part written, that, in the *Journal of Anatomy and Physiology* for last year, Dr. Dodds, in a very full and able discussion of the question, had adopted a similar threefold division. I am indebted to him for several references.

Physiological evidence.—The chief fact to be noted here is, that by electrisation of certain convolutions, particularly those bounding the fissure of Rolando, uniform and definite purposive movements always ensue; and that, for instance the stimulation of one point is followed by a certain complex movement of the forepaw, say, of a dog or monkey, and the stimulation of another point a little way off, by movements of the hind leg. Further, no movements of any kind are induced by stimulating most other portions of the cortex outside the proper motor area, such as the fore and back part of the brain in monkeys.

These facts may be regarded as established; but doubt still remains as to the interpretation of them. It has been strongly maintained that the movements are simply due to the conduction of electrical currents from the grey matter of the surface to the basal motor ganglia. Ferrier seems fairly to have met this objection, even though extra-polar conduction through the brain has been clearly demonstrated. For he urges that if the movements following electrical stimulation of the surface were due to conduction to the corpus striatum, and not to vital excitation of the cortical motor centres, then these movements should be of a general character, and involve the whole of the opposite side of the body, such as follow the immediate stimulation of these great centres; whereas, on the contrary, they are, as already stated, highly differentiated. He also asks the significant question,—how, on the theory of simple electrical conduction, is there no muscular action when the electrodes are applied to the island of Reil, which is so much nearer the corpus striatum than most parts of the motor convolutions?

Another and more important form in which this objection has been advanced is, that though the muscular contractions may not be due to the action of an extra-polar current, they may depend on the mere conduction of electricity from the motor centre to the basal ganglion, by means of the *special fibres* for the particular movements induced. This is opposed to Ferrier's theory, that electrisation stimulates the motor cells to develop a nerve current, which (and not the electricity) is transmitted to the ganglion below. After considering carefully the arguments on both sides, which cannot here be adduced, I would simply express my conviction that the facts in favour of vital stimulation are much the weightier, though the point can scarcely be said to be conclusively settled. The question does not affect the theory of localisation so far as it relates to definite pathways from the cortex to the inferior ganglia, as the existence of these is assumed by both parties.

The idea that the movements resulting from stimulation of the motor region may be due to reflex action, the surface in the area of the apparent motor centres being centripetal or afferent to the corpus striatum—need not detain us, for, as Dr. Dodds correctly urges, it is characteristic of an inter-central nexus in the higher ganglia, *i. e.*, the union between the upper centres of sensation and motion—that the connection is incomplete, and that the incoming impression may be followed by any one of a variety of habitual movements, not uniformly the same as those are which are under consideration.

That real but somewhat indefinite power, inhibition, has been called in to account for the motor phenomena. Brown Séquard is the most prominent supporter of this the inhibition hypothesis. It is held by him that the loss of power which apparently results from destruction of the centres in the motor area is really due to the fact that irritation of the injured part of the surface extends to the cells whose functions are made to disappear; such cells being in all cases those from which the fibres directly spring that proceed to the palsied part. He considers that the supposed inhibitory influence is quite similar to that of the vagus in controlling the action of the sympathetic nerves of the heart. Further, the movements that result from electrical stimulation of the same centres, he attributes to irritation of these ultimate cells, which is propagated to them from the surface; and he supposes that the movements are produced in essentially the same way as those that follow irritation of the skin, or mucous membrane, or any part of a centripetal nerve.

Besides other objections to this hypothesis, it is to be observed that the movements which follow stimulation of the motor area of the cortex, at different points, are uniform in their character; whereas, unless there be *definite* physiological connexion, as there is between the pneumogastric and sympathetic in the heart, the effect of inhibition is for the most part exceedingly variable; thus, ovarian irritation may induce paralysis, or anæsthesia, or insanity.

What may be called a *sensory* explanation of the apparent motor centres has been proposed. Hitzig himself is an advocate of this hypothesis. He now thinks that "muscular consciousness" is the special function of the seeming motor area in the convolutions. This view might possibly suffice to account for the evanescent character of the paralysis observed after destruction of these centres in the case of dogs, but it is not satisfactory as an explanation of the purposive movements due to electrical stimulation. Ferrier, too, maintains that no

proof has ever been submitted of the loss of that or of any other form of sensibility after the centres are destroyed. He also states that his experiments point to the hippocampal region as the centre for general sensation.

Turning now to the effects produced by destroying motor areas, the fact just mentioned, namely, the very temporary nature of the paralysis in the dog appears at first sight strongly opposed to the theory under discussion: thus, a few days after destruction of its motor centres, a dog is able to run about with little obvious defect in its locomotive power. Ferrier, however, finds that a similar operation in monkeys is always followed by a distinct loss of function—a result in harmony with the results of previous electro-stimulation. It will aid us in reconciling these apparently contradictory effects if we recall what was said respecting the plan of construction of the brain in the higher animals, and particularly in man. It was explained that specialisation of function attained its highest degree in the convolutions. Nerve cells are there combined for acts which require particular training, and which are habitually executed at the instigation of the will. Destruction of such centres might therefore be expected to cause loss of the more definite voluntary movements, while those of a grosser and more automatic kind, as in running, though possibly interfered with for a short time, would afterwards be restored. This explanation is supported by the fact recorded by Carville and Duret, that the delicate movements of the paw, to which a dog may have been educated, are permanently lost after destruction of the animal's cortical motor centres.

Ferrier, besides defining by his experiments the exact sites of motor centres in monkeys, which centres, it is to be observed, are probably not precisely the same in man, has indicated other portions of the brain's surface as the centres for sensation, special and general. For instance, he determines the angular gyrus as the centre for vision, and the superior temporo-sphenoidal convolution as the centre for hearing. The excitation of these parts induces movements which are held to show that the corresponding sensory functions are powerfully affected; but the effects of destroying them is even more conclusive, inasmuch as the particular sense or senses are thereby lost. Ferrier's conclusions, so far as they relate to the sense of sight, obtain valuable support from the results of M'Kendrick's experiments on pigeons. The fact that movements are produced by the electrisation of these supposed sensory centres raises the question whether they are purely

sensory or are at the same time partially motor. Ferrier holds the former opinion, and in support of it refers particularly to the absence of paralytic symptoms when the centres are destroyed. Still there is much to be said in favour of motor and sensory elements being associated in these parts of the cortex.

Pathological evidence.—In the first place, the facts of aphasia lend strong support to the theory of localisation. Observation of disease leads to conclusions in remarkable accordance with the results of experiments; for, as is well known, the site of the aphasic lesion is in and about the back part of the third frontal convolution, and Ferrier's observations on monkeys led him to localise the centre for speech in the same region. The curious fact that this centre is usually on the left side is now well established, and is most satisfactorily accounted for by supposing that, though there are corresponding parts on both sides of the brain, the left side alone is educated in the acquisition of language, which is paralleled, to a certain extent, by the fact that the nervous mechanism for the right hand is usually much better educated than that for the left.

During the last few years, more particularly, numerous cases of lesion in the motor area for the extremities have been recorded, and these cases, upon the whole, decidedly favour the theory of localisation. Some of them support the finer distinctions of Ferrier, while others, though corroborating the theory generally, do not favour it in detail. In this connection I may mention that, in 1869, I recorded a case of left hemiplegia, with superficial lesion of the right postero-parietal lobule. In discussing the pathology of the case, I stated my opinion that the paralysis, which was temporary, was probably due to the exhausting effect of the preceding convulsions, but added that a loss of motor power might result from a lesion entirely confined to the convolutions.

On the other hand, a large number of cases has been collected and quoted, particularly by Brown Séquard, in which hemiplegia and other palsies of cerebral origin were associated with lesions elsewhere than in the motor area. Many of these cases are not trustworthy, for a variety of reasons, but, putting them aside, there still remain some that at present stand distinctly opposed to the theory under consideration. With respect to these, it is worthy of recollection that it is proverbially difficult to prove a negative; and, therefore, though there was no gross lesion of the motor area noticed by the observers, there may possibly have been minute changes which were overlooked. Though certain facts seem

irreconcilable with the theory, they are not sufficient, in view of the large body of supporting evidence, to overthrow it. It would be far more damaging to its credibility if cases were submitted in which, with destructive lesion of a considerable portion of the motor area, there was or had been no palsy of voluntary movements; but no thoroughly reliable case of this kind has been published.

Not many cases have been recorded which illustrate the alleged existence of sensory centres in the cortex; still, there are a few which correspond closely with Ferrier's conclusions, particularly with respect to the centres for sight and hearing. Altogether, the evidence of this kind does not warrant a definite opinion on the locality of any of the supreme sense centres, though it favours generally a theory of localisation. Certain cases, either aphasic or allied to the aphasic state, may be cited in this connection. There are many speechless individuals who can comprehend what is said to them, but who have lost the power of understanding words in print or writing; as if their "perceptive centres" (Charlton Bastian) for hearing were sound, while those for vision were damaged. The converse of this occasionally occurs. In illustration:— Several years ago, an intelligent merchant told me that, for some months, he had been subject to a peculiar feeling which caused him much anxiety. He could hear as well as ever, he said, but somehow he could not properly or readily comprehend the meaning of the words. This was all that he felt wrong. I noticed that frequently, when a remark was made, his face had a puzzled expression. His hearing was good, and he had no difficulty in expressing himself in language. Two years since, when I last saw this gentleman, he had fully recovered. In this case there would seem to have been some morbid condition of the auditory perceptive centre.

The forms of Jacksonian epilepsy, as those cases are now named, in which the convulsions are local at the commencement are, upon the whole, not of great service in helping to determine the question. No doubt a number of cases have been recorded which are in striking harmony with Ferrier's views. The majority have been recorded by Dr. Jackson himself. A case of mine, already referred to in another connection, also distinctly supports the theory of cortical motor centres, as do likewise the cases of the two patients shown by me to this Society, in whom percussion of the skull materially assisted in localising the lesion. And besides these, a few others, recorded chiefly by French observers, may be placed under the same category. But, on the other hand, the cases

are not few which do not support localisation. These, however, may be satisfactorily explained by the hypothesis—that instability of grey matter, beginning possibly at a distance, has gradually extended till the motor region was involved; just as in the experiments of Ferrier, convulsions followed the prolonged electrisation of non-motor convolutions.

Anatomical evidence.—A few observations must suffice under this head. The descriptions given by such able observers as Meynert, Luys, Broadbent, and Flechsig, as to the course followed by the motor and sensory divisions of the crura cerebri as they pass upwards to the hemispheres, and particularly after they reach the corpus striatum and thalamus opticus, differ materially from each other; but there is a general concurrence in the opinion that the fibres of the crusta, the motor part, mainly proceed to the frontal and anterior part of the parietal lobes, while those of the tegmentum, the sensory part, pass to the more posterior convolutions. At the same time, it seems certain that there is no distinct limitation of these divisions; on the contrary, a not inconsiderable proportion of apparently motor fibres has been traced to the posterior part of the cerebrum, and of sensory fibres to the frontal lobes. It also seems clear that there is a considerable body of fibres of both kinds which, in their course upwards, altogether pass by the great basal ganglia, and proceed directly to the convolutions. The motor portion of this direct system of fibres is stated to be specially connected with the convolutions bounding the fissure of Rolando, and this opinion is supported by the secondary wasting that results from destruction of these convolutions, which wasting has sometimes been traced past the corpus striatum down through the crus cerebri to the motor columns of the cord. Imperfect development in motor convolutions has also been noticed in one or two cases of congenital defect, the most important case being that recorded by Gowers, in which the person—an adult—had been born without a hand.

Observations on the microscopical structure of the cortex support to some extent the theory we are discussing. It has been found that large pyramidal cells, with numerous processes similar to those in the anterior cornu of the spinal cord, abound particularly in the deeper layers of the cortex, and as it is almost certain that their function is motor in the former situation, it might be supposed that it will not be otherwise in the brain. But this would be too hasty a conclusion, especially when it is understood that such cells are found in other than reputed motor areas. All that can be

said is, that, upon the whole, minute anatomy favours the theory.

This closes our brief summary of the evidence. Though very incomplete, it may suffice to show that the two following positions are warranted. 1st. Though it cannot be held that the theory of motor centres in the convolutions is fully established, yet it is highly probable that there are such centres in what is known as the motor region. 2nd. It is probable that there are also separate centres for special and general sensation, but their locality is much less certain than the locality for the centres for movements.

The localisation of motor and sensory function in definite portions of the cortex seems to imply that other parts of the great hemispherical ganglia must be associated with the higher mental operations. There is, however, the utmost uncertainty on this point. In illustration, the opinions of two well known authorities may be referred to—Ferrier and Charlton Bastian. The former is disposed to localise the higher mental powers in the antero-frontal region of the brain, while the latter regards the posterior portion as the more probable site.

Before leaving this part of the subject, I would record my impression that most of the advocates of localisation, inclusive of Ferrier, by their writings convey an idea of its nature which the facts do not warrant, even admitting that they are sufficient to establish the two positions just stated. It seems almost to be taken for granted that, because certain movements follow the application of the electrodes in the motor area, the *whole* of the grey matter in that situation subserves motor or psycho-motor function. This is by no means a necessary consequence. On the contrary, anatomy specially points to the fourth layer as, if anywhere, the locality of that function; for there, according to the high authority of Betz, the large pyramidal cells are congregated,* though a few are found in the third layer also. These cells have processes which extend to the peripheral layers, and are in direct anatomical and physiological connection with them. Accordingly, electrisation of the surface may stimulate the deep motor cells through these processes, either by simple conduction of the current, or by extension of excited vital action from the possibly non-motor superficial cells. It may thus be that the

* This point was illustrated by diagrams showing the marked difference in the microscopical structure of the superficial and deep layers of the convolutions. These diagrams were kindly lent by Drs. M'Kendrick and Coats of Glasgow University.

proper motor part is only a small proportion of the whole thickness of the convolution, and that the main portion has a more purely psychic function. This remark is made with full recollection of the theory that our highest mental achievements are on the physical side only sensori-motor processes.

According to Ferrier and others, the cortical grey matter is abruptly divided in a vertical direction into two parts by the motor zone, which separates the sensory area behind from the higher psychic in front. No doubt it may be said that the association fibres, which are known to pass from convolution to convolution, and even between different parts of the same convolution, maintain unity of action between regions so separated. But, on anatomical and other grounds, this seems less probable than that the highest mental functions have direct and immediate connection with the whole extent of their physical basis, and therefore have their anatomical substrata in motor and sensory centres, as well as in other parts of the cerebral cortex: nor, as we have just urged, do the results of electric stimulation, when carefully considered, negative this hypothesis.

In a state of health the activities of the ganglionic centres of the brain, both high and low, are blended into one harmonious whole. When, however, they are the seat of disease, and especially when the morbid action affects one centre in particular, or begins in one, even though it should afterwards extend to many more, then not only does their existence become clear, but also their power of separate action. Thus, at the commencement of bulbar paralysis, disease, as indicated by the symptoms, may be strictly limited to the minute nucleus of the hypoglossal nerve, not involving any of the other nerve-nuclei in the medulla oblongata; though it usually implicates some of these as it advances. Our subject, however, relates to higher nerve function, and so refers us particularly to the region of the convolutions.

We have seen that the theory of cortical centres is worthy of general though qualified acceptance. Let us now look at its bearing on functional disorders, and first at the group which is included under the generic name of epilepsy. Till lately, and even yet by some authorities, the medulla oblongata was regarded as the great seat of this disease. In all probability the focus of morbid action in some cases is correctly localised there or in some other subordinate centre. But many, perhaps the majority, should rather be referred to one or other part of the cortex. This will appear if the symptoms are regarded for

a moment. We need not, however, consider the fully developed fit; the condition in it is too involved to yield trustworthy indications. But if we confine our attention to the milder forms of the disease, or to the initiatory features of the more severe attacks, the problem becomes less difficult. Most seizures begin with an aura, as it is called, in one or other form: it may be a feeling in or related to a special sense, or to general sensation, or to one of the systemic senses, or it may be entirely of a mental character. This simply means that the excited state of the centre involved is projected into consciousness and appears there as a manifestation of the function which the centre ordinarily discharges, though it may appear in a distorted form. We ought, then, to read the meaning of the aura, to see where it points to, for there the focus of the disease is situated. Thus, should the aura arise in the arm, or leg, or stomach, the morbid action has begun in the corresponding centre; the apparent peripheral development being, it need scarcely be said, explained by the physiological law that an impression produced on a nerve in its course or at its origin, is referred by the mind to the place of distribution of the nerve. Again, should the first symptom—which the aura is—be mental, as in a case recorded by Dr. Joseph Coats, where the fit always began with the recurrence of the same idea, then we must suppose that the part of the cortex affected does not include the centres for motion and sensation, assuming that the idea in question is not directly related to either of these functions. Once more, suppose the disease begins with the subjective feeling of an offensive smell, or with some subjective optical phenomena, then we may conclude that the centres for these senses are in a state of excitement.

Referring to the last illustration, it is to be observed that the nerves proceed at once to parts of the brain much higher up than the medulla oblongata, so that, in their case, at least, it would be an unwarrantable supposition that a morbid action in that lower situation could account for the initiatory symptoms. At the same time it is highly probable that in the acme of a severe fit the medulla is deeply involved, as well as other parts of the brain. This, however, is a secondary condition. The absurdity of localising the chief and primary seat of the disease in any of the lower centres ought to be clear when the symptoms at the beginning of the seizure are purely mental, for no one will dispute that the cortical grey matter is specially connected with the exercise of thought.

According to some high authorities epilepsy is to be as-

cribed to a morbid state of the sympathetic system of nerves. These authorities point to the sudden pallor of countenance that precedes the convulsions, and hold that a corresponding contraction of vessels exists within the brain. But it is a mistake to suppose that this preliminary pallor is an uniform condition in epilepsy. Not infrequently there is no change of colour observable, and occasionally a completely opposite state exists. A patient under my care at present illustrates the last observation. At the commencement of a fit he roars semi-articulately, and exactly in the same way on each occasion. This is accompanied by marked flushing of the face. Other symptoms are, unconsciousness, great mental excitement, distension and glaring of the eyeballs, and a disposition to rush forwards; sometimes, indeed, he knocks his head against the wall of his bed-room. There is no distinct convulsion even of the muscles of the eyes, or of the muscles about the mouth in these attacks. The flushing lasts from half a minute to a minute, and is followed by great pallor, which continues for about a minute more, and then gradually passes away. I have been present five or six times when such fits began, and the sequence I have mentioned has been the same in all of them. He is, however, also subject to attacks that commence in the same manner, but which afterwards develop into severe general convulsions, without intervening pallor. At the close of this form of attack his breathing is stertorous and his face livid, as is usual in convulsive epilepsy. Assuming, then, that the appearance of the face is a reliable index of the condition of the vascular system within the head, there may be, at the commencement of an epileptic seizure, a sudden contraction or a sudden relaxation of the cerebral vessels, or there may be no change at all.

But the phenomena of the auras belong to a prior stage, and point not to the sympathetic or vascular system, but to the nerve tissue itself, as the real seat of epilepsy. In brief, there would appear to be in most cases of epilepsy an unhealthy state of the cortical grey matter of the brain, most marked at the centre for the particular function whose subjective production constitutes the aura. Beginning at this part, which varies in different patients, the morbid action, probably that of excessive discharge, extends more or less generally according to the severity of the disease, and may implicate all the superficial grey matter as well as the basal ganglia, inclusive of the medulla oblongata; indeed, in the major attacks it seems rapidly to affect the brain, as a whole. In many cases, quite early in the fit, the part of the cortex in which the sym-

pathetic is specially represented becomes involved, and through this there results contraction of small vessels, inducing sudden anæmia, and thereby aggravating the convulsive tendency. The anæmia, it will be understood, is thus held, as already indicated, to be quite secondary, and to be due to the preceding abnormal action in the hemispherical ganglia.*

The morbid action in epilepsy has been spoken of as one of excessive discharge. Though it be somewhat of a digression from the main line of thought, I may be excused, owing to my own connection with the hypothesis, for dwelling on it at a little greater length. In illustration, I shall refer especially to the after phenomena of the fit. Some years ago, in certain cases of epileptic convulsions, affecting chiefly one side of the body, I noticed that the side most convulsed was afterwards palsied for an interval varying from a few minutes to some hours. The explanation that commended itself most to my mind was one that had been previously proposed by the late Dr. Todd, namely, that excessive discharge of the part of the brain most affected was followed by its temporary exhaustion. Dr. Hughlings Jackson, without being aware of these observations, explained the condition in epilepsy by the same hypothesis, but gave it the name of discharging lesion. Finding, however, that he had thus been anticipated, with scrupulous regard for the rights of others, Dr. Jackson at once acknowledged the fact, and further, did me the honour of associating my name with that of Dr. Todd, in relation to the hypothesis. It will be clear, however, that all the merit of priority is due to the latter. There is one point, however, in the character of the hemiplegia, which Dr. Todd did not

* In relation to this presumed extension of the pathological process from one centre to another, it is well to bear in mind the views of Spenser and Hughlings Jackson, referred to in an early part of this lecture. More particularly, according to Dr. Jackson, all parts of the body are represented in the cerebral cortex ; but, moreover, every little bit or, as he puts it, each unit of composition, represents potentially the whole processes of the body. However, each unit is not considered to represent or re-represent all the processes equally, but some very specially and others generally, "that is, in common with all neighbouring centres." Though concurring generally in this theory of representation, I am unable to accept it in this extreme form. It seems inconsistent with the comparatively simple and unmixed character of the combined movements, or special sensations, for example, those of smell and taste, that occasionally occur at the beginning of fits, to suppose that the whole body is represented, even in the most general way imaginable, in those parts of the cortex which these movements and sensations have as their centres. Equally does the supposition seem at variance with the marked separation of function brought out by Hitzig's and Ferrier's experiments.

notice, namely, the state of sensation. About two years ago, at a meeting of this Society, I showed a patient who was subject to convulsive seizures, followed by temporary palsy, in whom I had proved that the loss of power was accompanied by nearly complete loss of sensation, which was equally short in its duration. Evanescent anæsthesia as well as ephemeral palsy may, therefore, follow epileptic convulsions, particularly when these are chiefly on one side.

Dr. Jackson has applied the hypothesis in explanation of many more of the phenomena that follow epileptic attacks. I must, however, refer to his writings for a complete exposition of the whole subject. I will only illustrate it further by a case of my own published in 1873. It was that of a woman who had long suffered from epilepsy. The first symptom of each fit was the imagined appearance of a ball of red fire before her eyes. This was followed in about half an hour by unconsciousness and convulsions of the right side, and particularly of the right arm. For several hours after the fit, her power of recognising the colour red was greatly weakened; even scarlet appeared to be pale. There was no hesitation in naming other colours; nor had she any difficulty in distinguishing red during the intervals of the seizures. Besides this symptom there was also temporary hemiplegia, affecting the right arm most; and there was likewise aphasia, which lasted about twenty minutes. In this case there was apparent temporary exhaustion of the nerve structures, it may be both grey and white, related to the colour red, to the motor power of the right arm, and to the highest movements for speech; this exhaustion having been preceded by excess of neural discharge in the same parts.

Returning now to the theory of cortical localisation, we remark that besides affording a more satisfactory explanation of many forms of epilepsy than previous hypotheses have done, it enables us to account better for the grouping of symptoms and the general course of some other forms of nervous disease. Take the case of general paralysis of the insane. In this disorder psychical disturbance usually precedes defect in the articulation of words, but occasionally they begin quite simultaneously. Now it has been known since Calmeil first gave a full description of its pathology, that at the outset it is peculiarly a disease of the cerebral cortex: so that it was somewhat puzzling to explain the occurrence of a motor set of symptoms, seeing that the nearest motor ganglia were believed to be the corpora striata, but more especially as those concerned with speech were supposed to be confined to the

medulla oblongata. But the presence of motor centres in the superficial grey matter affords a ready solution of the difficulty, showing how there may be associated two kinds of symptoms *apparently* so very different from each other as delusion and defective articulation, but really closely allied, since the motor intuitions of language are so deeply concerned in the exercise of thought. The morbid changes observed in the brains of general paralytics are in accordance with this explanation of its pathology, for the most distinctive appearance is the adhesion of the pia mater to the grey matter of the surface, usually to such a degree, that they cannot be separated without a portion of the latter being torn off. And it is worthy of note, that this adhesion is most marked in the frontal and anterior part of the parietal regions, a fact, it will be apparent, that supports the theory of localisation, so far as it applies to motor centres.

In the early stage of the maniacal form of insanity, motor symptoms are occasionally a prominent feature. For many years I have been in the habit of directing attention to this point in my lectures to students. The symptoms consist of sudden startings and jumpings of the whole body, and are most marked at night in bed. They are associated with general irritability of mind, and in some cases with various sensory symptoms, such as an occasional feeling of elasticity in walking, which seems to pass upwards from the legs to the head. Similar startings may, however, be due to slight causes, such as indigestion in otherwise healthy people; and many women when pregnant suffer from them in their legs; but those to which I refer are more general, and are accompanied by the other symptoms mentioned. This combination of symptoms has also a ready explanation in the theory of the mental and motor relations of the cortex. But, in fact, the theory accounts well for the various sensori motor phenomena of fully developed insanity, such as "visions" and "voices;" these we may consider as due to implication of their highest centres, those, namely, of the convolutions, in the pathological process.

We have not enumerated all the forms of disease of the nervous system which may be most satisfactorily localised in the grey matter of the cortex, assuming the correctness of the views of the constitution and functions of the cerebral convolutions which have been described in this lecture; but those forms that have been mentioned are the most obvious, and may suffice as illustrations of the application of the theory of localisation in the explanation of disease.

There remains now for consideration only the all important question, Has there been, or is there likely to be, any practical application of this theory or doctrine—whichever it may be considered? Shall we be any the better able to treat morbid states of the nervous system by the knowledge that there are motor and sensory areas in the cortex of the brain? To this question we reply that already in several cases motor symptoms have been taken by surgeons, particularly in France, as guides to the seat of morbid action, and the skull, with successful results, has been trephined over the part of the brain which the character of the movements pointed out. This operation of trephining, which had fallen into comparative disuse, is then likely in future to be performed with greater precision and greater probability of success than in the past—a result which we owe to the experiments and observations that relate to the localisation of motor function.

Should there be fixed pain in the head in the motor region, the localisation of disease by symptoms becomes of course more certain. Such pain is often associated with disease of the skull, which is generally of a syphilitic nature. Besides this, which is by no means a new fact, I have also shown that even though no pain is complained of nor felt by the patient, it may be elicited at the diseased part by percussion of the skull with the point of the finger. The Society will remember that I demonstrated this fact on two patients who were shown at its meetings, the first occasion being in December, 1877. I was led to think of percussion as a means of diagnosis by the study of the first of these cases, which was one of localised convulsions. It occurred to me that, if the disease were on the surface of the brain, implicating the inner membranes, though these parts were not sensitive in health, they would be so if the seat of morbid change; and it seemed not unlikely that it might be possible, without hurting the patient, to transmit as much force by that means as would irritate the diseased part into sensibility. Accordingly, I percussed the skull with the result mentioned. I have now in four cases clearly developed pain of this kind, the patients being unconscious of any unpleasant sensation before percussion. In all of them, but particularly in three, the effect of counter-irritation over the painful part, so far as I could judge, was highly beneficial.

I remark, however, that though localisation suggested the idea of percussion, its application or usefulness has no con-

nection with that theory. Still, in two of my cases it has strikingly supported Hitzig's and Ferrier's views.

Let me here point out a necessary caution in percussing the skull. Great care should be taken to apply the same amount of force at each tap, and also to avoid suggesting to the patient, by remark or otherwise, any particular point of the skull. I am in the habit of first tapping the whole head with the finger, and then asking the patient if he feels pain at one place more than another: should this be so, I verify the observation by a second percussion.

My examination of patients does not lead me to expect that this new diagnostic measure will be of wide application; but I believe it will be of value sufficiently often to warrant its use in all cases where there is the least ground for suspecting the presence of disease on the surface of the brain, or in its membranes. *

In now drawing to a close, I remark that, though the practical gain directly to be ascribed to Hitzig's and Ferrier's observations on the localisation of cerebral function may not as yet be great, still, as in many another important discovery, the gain may afterwards become apparent by richer fruits. Inquiry, at least, is stimulated, and new fields of investigation are opened up, some practical and others speculative. The latter, the speculative class, relate to some of the deepest problems that can engage our thoughts, those, namely, that are concerned with the union between mind and matter. Objection has been taken to such studies for that very reason; it is urged that they lead to materialistic views of mind. But there is no reason why they should have that tendency. We are yet profoundly ignorant of the nature of mind, and of how it is associated with matter. Nothing really has been ascertained by these inquiries which throws doubt on the faith expressed in the words of the poet, "The soul shall flourish in immortal youth, unhurt amid the war of elements, the wreck of matter, and the crash of worlds."

* In the first part of the Journal *Brain*, for this year, Dr. Ferrier corroborates my observations respecting this test, and illustrates its application by a number of cases.

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CLINICAL OBSERVATIONS ON THE BLOOD OF THE INSANE.

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CLINICAL OBSERVATIONS ON THE BLOOD OF THE INSANE.*

By S. RUTHERFORD MACPHAIL, M.D. Edin.,

The older writers on Insanity including Pinel, and Esquirol, believed that functional disturbances of the higher nervous centres were the chief factors in producing mental disease. Whether this is the case or not, and whether functional disease of the brain may exist without appreciable change of structure, there can be no question that the quantity and quality of the blood circulating through the higher nervous centres affect their functions in an important manner.

First as to quantity. According to Bucknill and Tuke† the effect of blood on the brain, when in excess, is that of lethargy, while a diminution of its quantity is productive of syncope and unconsciousness. Both these conditions, described as congestion and anæmia, may be due to temporary irregularities in the supply of blood to the brain, and may pass away without leaving any ill consequences behind, although their frequent occurrence acting on a highly susceptible organism may produce minute changes, manifesting themselves by various morbid mental phenomena. Andral, quoted by Bucknill and Tuke, lays down the axiom that "in every organ the diminution of the normal quantity of blood which it should contain produces functional disturbances, as well as the presence of excessive quantity of blood." It is difficult to determine whether these alterations in the quantity of blood circulating through the brain are local or general in character, but it seems reasonable to premise that both conditions are possible. It is not, however, sufficient to refer mental symptoms to hyperæmia in one case and to anæmia in another, for they themselves are frequently mere effects. In this connection the importance of the vaso-motor system must not be overlooked. Maudsley‡

* The Essay which gained the Medal and Prize of the Medico-Psychological Association in 1884.

† "Psychological Medicine," page 586. ‡ "Pathology of Mind," page 193.

believes that all active emotions are accompanied by changes in the circulation, through vaso-motor inhibition, and that vascular disturbances may be produced by them within the brain very much as blushing of the face and neck is produced by shame. Irregularity in the blood-supply of the brain produces a condition of irritation of that organ, though this need not necessarily go on to actual mental disease. The sluggishness of the circulation in the extremities of many asylum patients, especially dements, is very noticeable; and if this be any criterion of the state of their cerebral circulation, there is little difficulty in accounting for their mental symptoms.

The quality of the blood may be impure from some error in the processes of digestion, assimilation, or excretion. To take the most common instance of this, the presence of bile in the blood, even in healthy and strong-minded individuals, gives rise to gloomy forebodings and melancholy conceptions. Also uric acid in the blood of a gouty patient causes an irritability of temper which is sometimes so severe that it passes into an outbreak of maniacal excitement. Arguing from such well-known facts as these, and knowing the effects of certain drugs, as chloroform producing anæsthesia, nitrous oxide gas producing laughter, and alcohol producing hilarity and excitement, we must admit that the brain may be affected through its nutrition, or, in other words, through the quality of its blood-supply.

Of course the affections of the nervous system must not be approached from the vascular side only, but this aspect of the question is worthy of attention. In this connection it is interesting to remark that nervine sedatives are more or less vascular depressants, and that nervine tonics tend to raise the blood pressure.*

The bodily symptoms of insanity have had a fair share of attention devoted to them in late years. If we believe, as many do, that mental disease can be regarded by the physician only as abnormal manifestation of the psychical function of the brain due to bodily conditions, it is desirable to investigate thoroughly the physical condition of all patients who are mentally affected.

Patients admitted into asylums may be broadly divided into three classes—

(1) A small group consisting chiefly of cases of recent

* "Handbook of Treatment," Fothergill, page 509.

insanity with no ostensible symptoms except those of mental derangement.

(2) A large group with well-marked symptoms of bodily disease which can be directly connected with the psychical symptoms.

(3) A group, intermediate in size, suffering from general debility or want of tone of the system, and in whom no organic or absolute physical disease can be detected.

Clouston* describes this third group as "such a lowering of the general condition of the body that it must be reckoned truly abnormal. This condition of body undoubtedly precedes certain forms of insanity and accompanies them. That there is no specific disease in most of such cases is proved by the recovery of many of them, and by the long life of many of the others." In 100 patients whose mental symptoms had lasted under six months, Dr. Clouston found 13 cases of this description. I have gone over the records of the last 500 patients admitted into this asylum, and I find that 47 men and 62 women of that number were in weak bodily health on admission, and in whom no specific disease was discovered after repeated physical examination. This excludes all old people over 65 years of age. Of these 109 cases 23 men and 29 women, or 47·7 per cent. of the total number, have been discharged recovered.

Griesinger† goes further than Clouston, and says that many inmates of asylums die from anæmia and marasmus without any serious local affection except perhaps a slight degree of atheroma of the vessels being discovered.

Chiefly with the object of ascertaining whether poverty of blood plays the same weighty predisposing part in the production of insanity that it does in the production of other diseases, I have made a series of observations, extending over a period of sixteen months, on the blood of insane patients. This is a field of clinical investigation which, so far as asylum-physicians are concerned, has as yet had little attention paid to it, although in the case of many diseases, physicians have been helped to a right diagnosis, and have derived many indications for treatment from a systematic examination of the blood.

The morphological elements of the blood in the normal state are the red and white corpuscles; by the aid of the

* "The Bodily Symptoms of Insanity." "Practitioner," 1871, Vol. ii., page 12.

† "Mental Diseases." New Sydenham Society's Translation, page 437.

microscope small granules floating in the serum may also be recognised, and when coagulation has taken place, a reticulum of fibrin. The colouring matter of the red corpuscles, or hæmacytes, which gives to the blood its red colour, is called hæmoglobin.

In examining the blood for clinical purposes there are three points to be considered—(1) Its richness in corpuscles; (2) The richness of the corpuscles in hæmoglobin; and (3) The amount of water diluting the corpuscles. Instruments of considerable precision, called respectively the Hæmacytometer and Hæmoglobinometer, have been devised for ascertaining the richness of the blood in corpuscles and in hæmoglobin. Inasmuch as the number of corpuscles present in any given bulk of blood is merely an expression of the proportion of corpuscles to the amount of plasma, variations in the number of hæmacytes counted might be caused by an increase or decrease in the quantity of plasma occurring, while the actual number of the corpuscles is stationary. Unfortunately we have as yet no means for determining this third factor during life, and this diminishes the value of results obtained by the above-named instruments.

All the methods devised for ascertaining the corpuscular richness of the blood consist in making a definite dilution of a certain quantity of blood, and counting the corpuscles in a certain volume of that dilution. Potain, Malassez, and Hayem have each devised an instrument adapted for clinical purposes, but their methods are cumbrous and inconvenient. The instrument I have used is Dr. Gower's hæmacytometer,* which is more simple for ordinary use, and is accurate enough for all practical purposes.

To eliminate as far as possible any instrumental error in the numerations, I invariably counted more than one drop of the mixture, and in the case of any marked discrepancy three or four drops have been examined and the mean of all the observations taken. The same instrument has been used throughout, and the blood to be examined was drawn from the finger without pressure.

The amount of hæmoglobin in the blood is ascertained by means of the hæmoglobinometer. The method consists in diluting a known volume of blood and comparing it with a standard solution. The average amount of hæmoglobin in

* For full description see "Lancet," 1st December, 1877, and "Practitioner," 1878, page 1.

each corpuscle is represented by a fraction of which the numerator is the percentage of hæmoglobin, and the percentage of red corpuscles the denominator. The observations with the hæmacytometer and the hæmoglobinometer were made simultaneously. Each observation took over half an hour to complete, and in not a few of the cases considerable difficulty was experienced in inducing patients to submit to the necessary puncture. The total number of observations represented by this paper is 420.

It is obvious that limitations of time and opportunity must narrow the scope of any experimental observations in such an extensive field of investigation; but the observations, which up to this time I have made may serve as an introduction to the further study of this important and interesting subject.

The special points I have endeavoured to determine are:—

(1) What is the amount of hæmoglobin and of red and white corpuscles in the normal condition of the blood?

(2) What is the condition of the blood in the class of patients who constitute the chronic inmates of asylums?

(3) Is the blood deteriorated in well-marked types of insanity, as General Paralysis and Epilepsy?

(4) Do variations occur in the blood of patients subject to attacks of periodic excitement?

(5) What is the state of the blood in patients when admitted?

(6) What is the state of the blood in patients who recover?

(7) What are the effects of various blood tonics on cases of recent insanity?

(8) Can any definite conclusions be arrived at from these observations which would be of practical value in the curative treatment of the insane?

I.

As a basis from which to work I first of all made a series of observations upon 30 cases of persons in presumably perfect health of body and mind. These, 15 males and 15 females, were selected chiefly from officials of the Asylum, and their respective ages ranged from 22 to 38 years. I give the results in a tabular form, showing the percentage amount of hæmoglobin and hæmacytes, and the proportion of white to red corpuscles in each instance.

A Table giving Percentage amount of Hæmoglobin and of Hæmacytes, and proportion of White to Red Corpuscles in the blood of 15 healthy persons of either sex.

Healthy Male Blood.				Healthy Female Blood.			
No.	Percentage of Hæmoglobin	Percentage of Hæmacytes.	Proportion of White to R. B. C.	No.	Percentage of Hæmoglobin	Percentage of Hæmacytes.	Proportion of White to R. B. C.
1	100	99·9	1 to 440	1	85	94·7	1 to 360
2	96	103·2	1 to 350	2	78	91·5	1 to 310
3	90	101·4	1 to 450	3	90	96·7	1 to 420
4	96	98·8	1 to 360	4	90	94·	1 to 280
5	90	99·2	1 to 430	5	88	90·9	1 to 360
6	100	102·4	1 to 480	6	80	93·2	1 to 380
7	90	99·	1 to 380	7	85	94·1	1 to 220
8	105	99·8	1 to 420	8	78	92·3	1 to 280
9	85	95·2	1 to 380	9	95	95·9	1 to 360
10	100	102·6	1 to 480	10	82	96·1	1 to 480
11	100	103·4	1 to 420	11	84	92·	1 to 380
12	95	102·5	1 to 340	12	88	91·7	1 to 430
13	95	101·9	1 to 440	13	80	89·8	1 to 210
14	104	105·1	1 to 510	14	90	95·2	1 to 290
15	95	102·7	1 to 450	15	86	94·8	1 to 460
Averages.	96	101·14	1 to 442		85·2	93·52	1 to 348

The average percentage of hæmoglobin is 96 in men and 85 in women. The variations are considerable, and there are greater fluctuations between the highest and lowest percentages in the observations in males than in those of females. The average number of red blood corpuscles per cubic millimetre is in men 5,075,000; and in women 4,676,000, or, expressing this in percentage form, male healthy blood, 101·14; female, 93·52. These results are rather higher than those of Laache,* who, in an analysis

* "Die Anämie" von S. Laache. Christiania, 1883. Reviewed "Medical Times," 1884, page 28.

of 60 cases, found the mean to be 4,970,000 per cubic millimetre for men, and 4,430,000 for women (99·4 and 88·6 per cent.). Speaking generally, we may represent the amount of red corpuscles in healthy male blood by 100, in females by a slightly lower percentage. In my observations the average proportion of white to red corpuscles is 1 to 442 for males; 1 to 348 for females. There were variations in the individual percentages and proportions, but these call for no special comment.

In the observations with the hæmacytometer a diluting fluid of constant strength, that recommended by Gowers, (sodae sulph. grs. 104, acid acet. ʒi, aquæ destill. ad ℥iv) was employed. This solution has some effect in changing the shape of the corpuscles, but has no influence on their diameter. The size of the red discs varies considerably, even in healthy blood. Hayem, quoted by Dr. Norris,* says that 75 per cent. of the corpuscles are of average size, 12 per cent. small, and 12 per cent. large. This is an important point, for it is obvious that if the small forms are more numerous, the average corpuscular diameter is lower than normal, and if there be a number of large cells in the blood under observation the corpuscular diameter of the cells is relatively increased. In my observations I simply made a general note of the relative size of the corpuscles in each instance, and did not attempt to go into detail. In healthy male and female blood the large majority of the hæmacytes were of an average uniform size, while large and small forms collectively did not exceed 10 per cent. of the total number. In two instances in the case of men I noted that large-sized corpuscles were more numerous than usual, and the blood of one female contained about 50 per cent. of blood discs below the normal size. In none of these cases, however, did the percentage of hæmacytes vary much from the normal standard.

Small granule-cells were observed in fully two-thirds of the cases. These small particles, called by some "hæmatoblasts," are a normal constituent of the blood, and, unlike the ordinary red blood corpuscles, are stained red by carmine. It is stated that they become relatively more numerous in blood which is undergoing recuperation. A few corpuscles were crenated, but I am not prepared to say whether this crenated condition of the cells was influenced by the diluting solution employed.

* "The Physiology and Pathology of the Blood," page 165.

II.

I adopted the following means for ascertaining the condition of the blood in the class who form the unrecovered residuum of asylum-patients:—I took 40 dements or chronic maniacs in average bodily health, and had them weighed periodically. These patients had been resident in the asylum for periods varying from four to 22 years, and none had been under medical treatment for some years previously. I give the series of observations in tabular form, dividing the cases into four groups according to age. I submit also a few remarks on each group.

B. Tables showing percentage of Hæmoglobin and Hæmacytes in the blood of a series of Dements at three different periods, and Weights at four different periods.

TABLE I.—TEN DEMENTS BETWEEN 20 AND 30 YEARS.

Case.	Period of Residence.	Weights in lbs. at four different Periods.				Percentage of Hæmoglobin.				Percentage of Hæmacytes.			
		Jan, '82.	June, '83.	Nov, '83.	Mar, '84.	June.	Nov.	Mar.	Average.	June.	Nov.	Mar.	Average.
1	6 yrs.	143	146	146	146	75	70	74	73	96·8	97·4	96·9	97
2	5 yrs.	134	130	128	129	64	66	65	65	95·7	90·8	92·2	92·9
3	8 yrs.	153	150	144	147	62	64	62	62·6	89·7	85·9	87·8	87·8
4	4 yrs.	160	164	162	162	65	68	65	66	88·6	90·1	89·5	89·4
5	4 yrs.	156	154	156	155	62	68	66	65·3	95·6	94·5	94·2	94·7
6	7 yrs.	158	156	155	155	70	68	62	66·6	94·7	93·3	94·1	94
7	5 yrs.	149	151	152	149	68	64	64	65·3	86·2	85·1	86·8	86
8	11 yrs.	139	144	146	145	68	68	68	68	87·7	89·2	88·5	88·4
9	7 yrs.	133	125	126	126	55	55	55	55	82·7	81·8	82·2	82·2
10	4 yrs.	164	159	158	158	70	72	72	71·3	91·4	92·1	91·8	91·7
Avgs.	6·1	148·9	147·9	147·3	148·03	65·9	66·3	65·3	65·8	90·91	90·02	90·40	90·44

The period of residence of the patients varies from four to 11 years. Their weights range from 126 to 164 lbs., and it will be observed that the weights, taken at four different periods in 26 months, show slight variation in individual instances, the difference never exceeding 7 lbs., while the

average weight for the 10 patients at each period of the year is very uniform. The percentage of hæmoglobin is considerably below normal, and varies from 55 to 75 per cent., as compared with 96, the normal standard. While the amount of hæmoglobin varied in individual cases, the percentage in each is very uniform at the three different periods, thus showing that the season of the year has little effect on the quantity of hæmoglobin. Although the lowest percentage of hæmoglobin was observed in the lightest patient, it is not clear that we are justified in assuming any relation between the variations in weights and variations in the percentage of hæmoglobin, for in two of the cases a higher percentage was registered during the period when the weight was lowest. The percentage of hæmacytes varies from 3·7 to 19·3 below normal, while the average is fully 10 per cent. below the standard. As in the case of the hæmoglobin, there are variations in the absolute and relative averages at different seasons of the year; but this does not occur in such a precise form as to enable one to make any deductions.

TABLE II.—TEN DEMENTS BETWEEN 30 AND 40 YEARS.

Case.	Period of Residence.	Weights in lbs. at four different periods.				Percentage of Hæmoglobin.				Percentage of Hæmacytes.			
		Jan, '82.	Nov, '83.	Feb, '84.	May, '84.	Nov.	Feb.	May.	Average.	Nov.	Feb.	May.	Average.
1	18 yrs.	166	162	167	164	70	70	70	70	92·8	92·6	91·8	92·4
2	14 yrs.	148	150	148	148	70	70	72	70	92·1	91·7	92	91·9
3	11 yrs.	139	133	136	136	68	74	70	70·6	89·2	92·0	90·7	90·6
4	9 yrs.	138	138	139	138	66	70	64	66·6	86·7	90·9	87·8	88·4
5	14 yrs.	170	166	166	164	66	68	68	67·3	90·5	86·1	88·4	88·3
6	21 yrs.	151	150	147	148	74	68	72	71·3	93·9	92·5	92·8	93
7	9 yrs.	121	116	120	119	65	64	65	64·6	86·5	83·8	85	85·1
8	6 yrs.	135	129	130	128	60	58	62	60	87·4	89·7	87·9	88·3
9	4 yrs.	152	152	150	152	75	70	72	72·3	89·2	90	88·7	89·3
10	11 yrs.	138	135	130	124	58	60	60	59·3	85	87·2	85·6	85·9
Avgs.	11·5	145·8	143·0	143·3	142·1	67·2	67·2	67·5	67·3	89·33	89·65	89·07	89·35

It is worthy of remark that we have diminution of the percentage of corpuscles with an increase of hæmoglobin. The converse likewise occurs, and we have a decrease in the percentage of hæmoglobin and an increase in the number of corpuscles.

The average period of residence of the patients in this group is 11½ years. There is a greater variation in the weights at different periods than in the previous group, one patient alone losing 14 lbs. in 29 months, while the average loss of weight for the 10 patients during that period is 3·7 lbs. The percentage of hæmoglobin is very uniform, both in the individual cases and in the average of each period. The average amount of hæmoglobin is slightly higher than in the first group. On the other hand, the average number of hæmacytes is 1·1 per cent. lower, while the variations in the averages for each period of the year are more uniform, and the individual averages are less uniform than in Table I. There appears to be no relation between variation in weight and increase or decrease in the percentage of hæmoglobin and hæmacytes.

TABLE III.—TEN DEMENTS BETWEEN 40 AND 50 YEARS.

Case.	Period of Residence.	Weights in lbs. at four different periods.				Percentage of Hæmoglobin.				Percentage of Hæmacytes.			
		Jan, '82.	Dec, '83.	Mar, '84.	May, '84.	Dec.	Mar.	May.	Average.	Dec.	Mar.	May.	Average.
1	15 yrs.	160	158	156	154	75	70	70	71·6	96·1	91·7	92·5	93·4
2	7 yrs.	158	150	148	148	65	68	65	66	89·2	96·1	92·2	92·5
3	20 yrs.	140	133	132	132	62	64	64	63·3	90·8	89·5	90·8	90·3
4	5 yrs.	150	154	150	150	78	75	75	76	95·1	91·5	91·9	92·8
5	6 yrs.	152	151	154	154	65	65	68	66	91·7	94·1	92·7	92·8
6	17 yrs.	164	158	162	161	65	68	68	67	88·9	91·7	87·9	89·5
7	22 yrs.	140	144	139	138	64	65	65	64.6	88·9	90·2	89·1	89·4
8	18 yrs.	184	190	190	196	64	65	64	64·3	87·8	89·2	88·1	88·3
9	22 yrs.	154	154	152	150	58	55	58	57	79·3	79	80·9	79·7
10	15 yrs.	140	137	139	136	62	65	60	62·3	84·6	85·7	83·9	84·7
Avgs.	14½	154·2	152·9	152·2	151·9	65·8	66·0	65·7	65·8	89·24	89·87	89	89·37

The special points in this table are : An average period of residence of 14½ years ; an average loss of weight of 2·3 lbs. in 29 months ; an average percentage of hæmoglobin similar in amount to that in Table I., but less than in Table II. ; a lower percentage of red corpuscles than in either of the previous groups.

TABLE IV.—TEN DEMENTS BETWEEN 50 AND 60 YEARS.

Case.	Period of Residence.	Weights in lbs. at four different periods.				Percentage of Hæmoglobin.				Percentage of Hæmacytes.			
		Jan, '83.	Dec, '83.	Mar, '84.	May, '84.	Dec.	Mar.	May.	Average.	Dec.	Mar.	May.	Average.
1	14 yrs.	172	176	174	175	65	68	68	67	87	86·9	87·8	87·2
2	22 yrs.	118	108	108	110	74	68	70	70·6	87·4	87	88·9	87·7
3	12 yrs.	156	155	*—	—	66	—	—	66	87·7	—	—	87·7
4	22 yrs.	158	154	148	152	68	70	65	67·6	87·8	87·1	86·6	87·1
5	13 yrs.	172	168	172	173	55	60	60	58·3	88·4	87·3	87·8	87·8
6	7 yrs.	163	158	156	158	68	70	70	69·3	87·7	86·9	86·5	87
7	15 yrs.	174	176	172	172	70	70	70	70	86·3	85·9	86·7	86·3
8	22 yrs.	148	148	154	149	70	72	70	70·6	86·7	87·2	87·2	87
9	22 yrs.	175	171	170	166	60	58	60	59·3	87·4	86·9	85·4	86·5
10	22 yrs.	138	143	145	147	58	60	58	58·6	87·8	89·2	88·6	88·5
Avgs.	17·1	157·4	155·7	155·4†	155·7†	65·4	66·2†	65·6†	65·73	87·42	87·15†	87·27†	87·28

* Died of Pneumonia, March, 1884. † Average of Nine Observations.

This table is incomplete, inasmuch as one of the patients died of an intercurrent attack of pneumonia, and his blood was examined only on one occasion. The table, however, brings out more forcibly the diminution in the average percentage of red corpuscles noted in the third group.

The proportion of white to red corpuscles was also ascertained, but as they showed so little variation from the normal standard, I have not given the results in the tables.

The relative size of the corpuscles was fairly uniform.

There was an almost complete absence of small forms, though corpuscles of large size were observed in several of the cases. Small granule-cells were seen in only six of the 40 cases under observation, and when they were detected they were ill-defined, and did not occur in groups, as is the case in normal blood.

Of these 40 patients, six in the first group, five in the second group, three in the third group, and four in the fourth group had a course of ferruginous or nervine tonics during the earlier period of their residence in the asylum, but in no instance had tonics been administered during the three years preceding the observations.

Four patients in the first group, three in the second, and one in the third group were known to be masturbators, and it is worthy of remark that the average percentages of hæmoglobin and of hæmacytes in these cases were rather below the percentages in the tables in which the observations on their blood is detailed. With the object of seeing whether this was merely a coincidence, I examined the blood of four other patients known to be addicted to masturbation; and, without entering into detail, I am in a position to state that the percentage of hæmacytes in the patients examined was considerably below the normal standard, while the amount of hæmoglobin was also diminished, though to a less extent.

Summarising the results of my observations on the class of dements or chronic maniacs, an examination of the fore going tables appears to warrant the following conclusions:—

(1) The percentage of hæmoglobin is considerably below the normal standard, and does not appear to be influenced by the age of the patients.

(2) The percentage of hæmacytes is likewise diminished, and this diminution progresses with the age of the individual.

(3) The proportion of white to red corpuscles is normal.

(4) The blood is deficient in hæmatoblasts.

(5) In the patients over 30 years the weight decreases, but this decrease does not appear to influence the relative percentage of hæmoglobin and of hæmacytes.

(6) The period of residence and the season of the year do not affect the absolute proportional averages of the constituents of the blood.

III.

While the condition of the blood vessels in General Paralysis has been a subject of discussion by many observers, and the state of the pulse, including sphygmographic tracings, has engaged the attention of Thompson* and others, I have been unable, in the literature to which I have had access, to find reference to any observations on the state of the blood in this disease.

With the object of ascertaining the condition of the blood in General Paralysis, I selected five typical examples of male general paralytics at three different stages of the disease, and examined their blood. The three periods selected were (1) on admission, (2) in the demented and lethargic condition, and (3) in the bedridden and completely paralysed stage. The results are given in tabular form (C).

C. Tables showing the Quality of the Blood in Male General Paralytics at three different stages of the disease.

I. Five General Paralytics on Admission.

No.	Age.	Probable Duration of Disease.	Percentage of Hæmoglobin.	Percentage of Hæmacytes.	Proportion of White to Red Corpuscles.
1	40	6 mos.	68	89·2	1 to 280
2	36	12 mos.	62	88·1	1 to 350
3	32	9 mos.	66	88·4	1 to 260
4	45	3 mos.	70	90·3	1 to 310
5	48	4 mos.	65	87·6	1 to 340
Averages	40·2	6·8 mos.	66·2	88·7	1 to 308

II. Five General Paralytics over Six Months after Admission.

No.	Age.	Period of Residence.	Percentage of Hæmoglobin.	Percentage of Hæmacytes.	Proportion of White to Red Corpuscles.
1	32	Over 3 years	75	89·9	1 to 250
2	54	,, 9 mos.	65	87·6	1 to 130
3	67	,, 1 year	72	85·3	1 to 180
4	52	,, 1 year	70	84·4	1 to 180
5	38	,, 9 mos.	68	85·3	1 to 140
Averages	48·6	Over 15 mos.	70	86·5	1 to 176

* West Riding Reports, Vol. i.

III. Five General Paralytics in Last Stage, Bedridden and Paralysed.

No.	Age.	Period of Residence.	Percentage of Hæmoglobin.	Percentage of Hæmacytes.	Proportion of White to Red Corpuscles.
1	49	Over 18 mos.	58	77·6	1 to 140
2	51	,, 16 mos.	64	81·1	1 to 140
3	42	,, 8 mos.	55	68·9	1 to 110
4	50	,, 6 mos.	66	82·5	1 to 120
5	45	,, 9 mos.	60	80·4	1 to 110
Averages	47·4·	Over 11 mos.	60·6	78·1	1 to 124

From an analysis of the first of these tables we find that the average percentage of hæmoglobin is 30 per cent. below the normal standard, and that in individual cases, with one exception (No. 5), the longer the probable duration of the disease the lower is the percentage. The percentage of hæmacytes is also diminished, though to a less extent; and as in the case of the hæmoglobin, with one exception (No. 5), this decrease is coincident with the duration of the disease. The proportion of white to red corpuscles is increased, but this increase does not appear to vary in the same ratio as the hæmoglobin and hæmacytes with the duration of the disease.

The second table is composed of patients in the quiescent stage of the disease, who have resided in the asylum for an average of over fifteen months. The most noteworthy features in this series are an increase in the percentage of hæmoglobin and in the proportion of white to red corpuscles, and a decrease in the percentage of hæmacytes. An interesting point in this table is that, contrary to what one might expect from the preceding table, the percentage of hæmoglobin is higher, and the proportion of white to red corpuscles is lower in relation to the length of residence of the individual patients. There is also a similar increase in the relative proportion of hæmacytes, but there are two exceptions (Nos. 2 and 4) to this. The average percentage of hæmoglobin is higher, and the average percentage of hæmacytes is lower, than in the case of ordinary demented patients at the same age.

The third group is selected from advanced cases of paresis. In two instances (Nos. 1 and 3) the patients died on the day succeeding the observations, and in both these cases the percentages of hæmoglobin and of hæmacytes are very low. In

all the five cases the relative proportions of hæmoglobin and hæmacytes are much below the percentages in either of the preceding groups. The proportion of white to red corpuscles is much increased.

In the last group the blood in each instance was dark, venous in character, and drawn with difficulty from the finger. In the hæmacytometric observations the individual corpuscles were so irregular in outline and deformed that it was deemed advisable to examine the blood on a slide in the ordinary way. The white corpuscles were much increased; there was little tendency of the red corpuscles to form rouleaux; in all the cases the individual corpuscles were crenated; in two they were irregular in outline, and in one observation many of the corpuscles were tailed or had processes. In two cases in the second group the blood contained a large number of corpuscles of small size; in two the larger proportion of the corpuscles were crenated; and in one their outlines were irregular. In both the first and second groups the blood was darker than normal. Small granule cells were observed in four instances in the first series, twice in the second, and not at all in the last series.

These observations may be summarised thus :—

(1) The percentage of hæmoglobin is low on admission, it improves in the quiescent stage of the disease, and falls again in the paralytic stage.

(2) The red corpuscles deteriorate both in quality and quantity coincident with the progress of the disease.

(3) Small granule cells are not present in the blood during the last stage.

(4) The relative proportion of white to red corpuscles is increased, and this increase is coincident with the progress of the disease.

Defective nutrition of the body, including anæmia, has long been recognised as a predisposing cause of epilepsy. In idiopathic epilepsy no constant anatomical lesion has been discovered, and it may therefore be inferred that the lesion is a molecular one. According to Nothnagel's theory, continued excitation of the vaso-motor centre is the necessary pathological condition of the epileptic paroxysm. In other words, he believes that irritation of the vaso-motor centre causes contraction of all the arteries of the body, including those of the brain; and that the anæmia caused by the contraction of the vessels of the brain is the active factor in producing epilepsy. He has not, however, so far as I am aware, supplemented this theory by recording a series of observations on the blood of epileptics.

In this asylum all the male epileptic patients, with three exceptions, have, as part of their routine treatment, continuous doses of Bromide of Potassium (grs. xxx thrice daily), and many of the patients have had this treatment with occasional intermission for a number of years.

With the object of determining whether the blood is deteriorated in patients suffering from epilepsy, as Nothnagel's theory suggests, I have examined the blood in a series of epileptics. As all the patients were being treated with continuous doses of Bromide of Potassium, I have taken as the bases of my observations the length of time this treatment had been carried on.

D. Tables showing Condition of the Blood in Male Epileptic Patients treated with 90 grain doses daily of Bromide of Potassium for different periods.

I. Five Epileptic Patients on Admission.

No.	Age.	Percentage of Hæmoglobin.	Percentage of Hæmacytes.	Proportion of White to Red Corpuscles.
1	45	65	87·9	1 to 320
2	20	68	82·4	1 to 350
3	38	68	82·9	1 to 220
4	26	60	76·9	1 to 200
5	27	62	81·3	1 to 410
Averages	31·2	64·6	82·28	1 to 300

II. Five Patients who have taken Bromide of Potassium continuously for more than Two and less than Five Years.

No.	Age.	Percentage of Hæmoglobin.	Percentage of Hæmacytes.	Proportion of White to Red Corpuscles.
1	29	68	88·5	1 to 350
2	27	70	92·7	1 to 220
3	29	72	93·8	1 to 190
4	34	72	88·2	1 to 380
5	22	75	89·4	1 to 400
Averages	28·2	71·4	90·52	1 to 308

III. Five Patients who have taken Bromide of Potassium continuously for more than Two and less than Five Years.

No.	Age.	Percentage of Hæmoglobin.	Percentage of Hæmacytes.	Proportion of White to Red Corpuscles.
1	23	75	87·9	1 to 500
2	44	60	85·4	1 to 380
3	33	74	89·2	1 to 380
4	33	75	90·8	1 to 310
5	31	80	93·2	1 to 240
Averages	32·8	72·8	89·3	1 to 362

IV. Five Patients who have taken Bromide of Potassium continuously for more than Ten and less than Fifteen Years.

No.	Age.	Percentage of Hæmoglobin.	Percentage of Hæmacytes.	Proportion of White to Red Corpuscles.
1	36	60	85·3	1 to 400
2	33	75	96·3	1 to 340
3	49	70	90·1	1 to 360
4	32	80	93·2	1 to 360
5	35	72	89·6	1 to 340
Averages	37	71·4	90·9	1 to 360

V. Five Patients who have taken Bromide of Potassium continuously for over Fifteen Years.

No.	Age.	Percentage of Hæmoglobin.	Percentage of Hæmacytes.	Proportion of White to Red Corpuscles.
1	53	70	89·6	1 to 440
2	41	70	86·2	1 to 480
3	32	60	85·7	1 to 560
4	53	75	90·6	1 to 380
5	66	65	90·7	1 to 220
Averages	49	68	88·56	1 to 416

Clouston * states that patients gain in health and weight while taking average doses of Bromide of Potassium, and his observations are corroborated by Hughes Bennett † in a recent paper on the prolonged administration of the Bromides in Epilepsy.

Analysing the tables (D) we find:—(1) As to hæmoglobin, that on admission the average percentage is considerably below the normal standard; that the blood improves in this respect during the first 10 years of treatment, after which there is a slight decrease; and that the percentage of hæmoglobin in epileptic dements is slightly higher than in ordinary dements at the same age. (2) That the average amount of hæmacytes in the blood of Epileptic patients when admitted is almost 20 per cent. below the normal standard; that with slight fluctuations the blood improves during the next 15 years, after which there is a slight deterioration; and that the percentage of hæmacytes is a fraction higher in epileptics than in dements at the same age. (3) That the proportion of white to red corpuscles diminishes in ratio to the period of residence. (4) That the quality of the blood improves during treatment with bromide of potassium, and that the prolonged use of the drug exercises no deteriorating influence in decreasing the percentages of hæmoglobin and of hæmacytes.

There was considerable variation in the size of the individual corpuscles. In two instances more than one-fourth of the hæmacytes were of large size. These cases were Nos. 1 and 2 in Table III., and probably this fact influenced the average percentage in this group; for, as I have already stated, the larger the individual corpuscles, the fewer can be counted in the square of the hæmacytometer. In Nos. 2 and 4 in Table IV. the larger proportion of the corpuscles were small in size, and this, of course, would affect the general average in the opposite direction. In several other instances the blood-cells were of varying size, but not to such a marked extent as in any way to affect the results. Crenated corpuscles were observed in about half the cases, and cells with irregular outlines were occasionally met with. Small spherical bodies were noticed in a large proportion of the cases, especially in the first three groups.

IV.

In order to ascertain what variations occur in the blood of patients subject to periodic attacks of excitement, I selected

* "Journal of Mental Science," Oct., 1868.

† "Lancet," 1884, Vol. i, page 883.

six female patients of this class and made a series of observations on their blood. The number of observations was 68. As it is difficult to represent the results in a tabular form without taking up more space than the limits of a short paper will allow, I shall not attempt to do more than summarise the series of observations as briefly as possible.

In two instances the observations represent a period of one year. Twenty-three observations in the case of one, and 20 in that of another patient. In other two the observations were taken over a period of nine months, eight in one case, seven in another. In the two remaining cases five observations were made on each, within a period of six months. The ages of the patients varied from 18 to 44 years, and with one exception they had resided in the asylum for over a year. The observations were made on each patient in all the various stages of the attacks of excitement, and also in the intervals between the attacks when the patient was either in a quiescent, partly demented condition, or on the other hand was to all appearance in a normal mental state.

In the two patients in whom the observations were continued periodically for a year each passed through seven attacks of excitement, varying in duration from 30 hours to two months. In the cases where the observations represent a period of nine months' duration, and in one of those during a period of six months, there were three attacks of excitement in each. In the remaining case there were two outbursts of maniacal excitement. Of these six individuals two have been discharged recovered, one has drifted into dementia, and three continue to have periodic attacks of excitement.

The weights of the patients were taken periodically. Considerable variation occurred in each instance. One patient lost 12lbs. in one month during a prolonged attack of excitement, while another gained 8lbs. in three weeks of freedom from excitement between two attacks. Short periods of excitement had little effect in altering the weight, but when a maniacal outburst lasted over a fortnight there was usually a sensible diminution in weight. The two cases which recovered were those which showed the least depreciation in weight even during the periods of excitement, and were likewise those in which the greatest gain in weight took place.

The percentage amount of hæmoglobin varied from 56 to 80. The lowest percentage occurred during the fifth week of an attack of excitement, the highest was registered when the patient had kept free of excitement for 28 days, and two days

before the commencement of another maniacal outburst. The greatest variation in an individual case was from 58 per cent. to 80 per cent. In the earlier period of the attacks of excitement the hæmoglobin in many instances did not diminish in quantity, and in two instances the patient passed through an attack of excitement of a week's duration, leaving the percentage of hæmoglobin higher at the end of the attack than it was at the commencement. This, however, was exceptional, and in 16 of the 25 attacks of excitement represented by these six individuals, the amount of hæmoglobin diminished during the attack; in the remaining nine attacks no change in the percentage of hæmoglobin was recorded. With a few trivial fluctuations, the decrease in the percentage of hæmoglobin progressed in apparent ratio with the length and severity of the attack of excitement.

The lowest percentage of hæmacytes recorded was 79·7, and the occasion was the 13th day of an acute attack of excitement which rapidly followed a similar attack lasting one month. The highest percentage (93·6) occurred in the same patient during convalescence from a third attack of excitement. This patient had no further relapse, and has since been discharged recovered.

The greatest fluctuation in the amount of hæmacytes in the three cases which remain *in statu quo* is also worthy of remark. In one case the highest percentage (91·8) was registered on the seventh day, after an attack of excitement had passed off; the lowest (81·3) on the 19th day of an acute maniacal attack. In the second case the highest percentage (88·7) occurred on the second day of an acute attack of excitement, the patient having been quiet for three weeks previously, the longest period of freedom from excitement during the year; the lowest percentage (80·7) on the third day after settling down from an attack of excitement which had lasted two months. In the third case the highest percentage was 89·6, and the lowest 84·5; the one occurred during a period of freedom from excitement, the other during a prolonged maniacal seizure.

In the 68 observations with the hæmacytometer 30 were taken when the patients were free of excitement, 38 while they were in an excited state. The average of the first observations was 87·8, that of the second series 84·8 per cent. Thus we see that, taking the cases in bulk, there was a decrease of three per cent. in the observations made while the patients were excited. Though there are a few exceptions, this fact is brought out in an examination of the individual cases and of the

individual attacks. As in the case of the hæmoglobin, the decrease apparently progresses in relation to the length and severity of the attack of excitement. Another noteworthy point is that the decrease in the percentage of hæmacytes during an attack of excitement progresses more rapidly than the increase during convalescence or between attacks. For example, in one case the percentage of hæmacytes decreased in 14 days during an attack of excitement from 87·5 to 81·3; for the next fortnight the patient kept free of excitement, and during that time the percentage only increased to 84·4.

The proportion of white to red corpuscles varied from 1 in 170, to 1 in 480. The average of the 68 observations was 1 in 312. There were considerable variations in the proportions in each of the six cases, the proportions in one individual fluctuating between 1 in 210, and 1 in 410. These fluctuations, however, did not occur in any constant ratio to the mental condition of the patients at the time of the observation. Although the proportion of white corpuscles was lower in the observations during the periods of freedom from excitement (30 observations, 1 in 317; 38 observations, 1 in 308), the variations were so numerous and irregular that no general conclusion was possible. Crenated corpuscles were observed more frequently in the periods of quiescence than when the patients were excited. Small and irregular forms were more numerous during the excited stage, while small granule cells were observed with equal frequency at both periods.

A more extended series of observations and greater frequency of examination in individual cases are necessary before one is justified in forming many deductions from the foregoing researches on the blood of female patients subject to attacks of periodic mania. There is one possible source of fallacy to which my attention was not drawn till I had completed my observations, and which in a great measure detracts from the scientific value of this portion of the subject. I refer to the influence of the catamenia in lowering the percentage of the blood corpuscles. Hunt * in a large number of observations on chlorotic anæmia, has shown that a definite numerical fall in the number of hæmacytes occurs shortly before the onset of the menstrual flow, and other observers, notably Gowers † and Willcocks' ‡ have made similar statements. It would be

* "Lancet," July 17th, 1880. † "Practitioner," Vol. xxi, p. 11.
‡ "Practitioner," Vol. xxxi, page 103.

advisable, therefore, in view of this statement, to pay attention to the menstrual period in any further observations.

I therefore submit the following deductions, recognising that the results may possibly be fallacious :—

(1.) Prolonged periods of excitement cause a reduction in weight.

(2.) The percentage of hæmoglobin is less during an attack of excitement than in the periods of quiet preceding and following the attack.

(3.) During an attack of excitement the average amount of hæmacytes is less, and small forms are more numerous than in periods of freedom from excitement.

(4.) Maniacal attacks do not appear to influence to any great extent the relative proportion of white to red copuscles

(5.) The more prolonged and severe the attack of excitement the greater is the deterioration in the quality of the blood.

V.

The tables in this section (E 1 and E 2) represent fifteen consecutive admissions of either sex. These may, I think, be regarded as fairly typical examples of the class of patients admitted to asylums. None of the cases were transfers from other asylums.

The points in the tables which call for special comment are— (1) The ages of the male patients vary from 20 to 58 years, average 36·5 years; the females from 21 to 63 years, average 35·4 years. There appears to be no uniform relation between the ages of the respective individuals and the quality of their blood. (2) The weights also show considerable variation, between 108 lbs. the lowest and 164 lbs. the highest for men; and 83 lbs. and 154 lbs. for women, the respective average weights being 136·7 lbs. and 110·2 lbs. The relation of the weight to the quality of the blood is by no means constant, although the blood of the larger proportion of the heavier patients is richer in hæmoglobin and in hæmacytes than in the case of the male patients whose weights are below 128 lbs., and the female patients below 100 lbs. (3) The duration of the mental symptoms on admission varies from one week to four years in men, and from three days to two years in women. There appears to be some connection between the duration of the attack and the amount of hæmoglobin and hæmacytes in the blood. In the male series, of six cases with a percentage of hæmoglobin of 70 or over, in five the symptoms had lasted under a month, while in three of the four highest percentages

of hæmacytes the mental disease was of short duration (ten days and under). A prolonged duration of attack does not however necessarily cause a deterioration, for in the four cases where the symptoms had lasted a year and upwards the average amount of hæmoglobin is 68, and the average of hæmacytes 87 per cent., or a fraction above the averages in the tables. While the exceptions are more numerous in the female group, in these also the blood appears to deteriorate in quantity of hæmoglobin and hæmacytes *pari passu* with the length and severity of the attack. (4) The quality of the blood varies considerably in the different types of mental disease. In the three epileptics in Table E. I., the average amount of hæmoglobin is 2 per cent. below the average for the fifteen cases, while the average percentage of hæmacytes is reduced to 80·7. General Paralytics also have a low percentage of hæmoglobin, while the amount of hæmacytes is above the average in the table. In the melancholic type the hæmoglobin is below, and the hæmacytes are above the general averages. The highest percentages of hæmoglobin and hæmacytes are found in the three cases of acute mania, and in one patient suffering from *delirium tremens*. In the remaining cases of mania there are considerable fluctuations in the quality of the blood. In Table E. II., the average percentages of hæmoglobin and hæmacytes in the eight cases of mania are 61 and 78; in the five cases of melancholia 59·2 and 81·5. In other words, the hæmacytes are below the average of the fifteen cases in mania, while the hæmoglobin is decreased and the hæmacytes are increased in melancholia. (5) Seven men and seven women are stated to be in weak bodily health. Only three of these had active physical disease, viz., one man convalescing from an attack of pneumonia, and two women in a very feeble state suffering from bronchitis. The bodily health does not appear to affect the quality of the blood in a uniform ratio, for the three patients, physically ill, occupy a middle position in the series in this respect, and one female in good bodily health has a low percentage of hæmoglobin and hæmacytes. (6) In males the percentage of hæmoglobin is almost 30 below the normal standard, the average of the fifteen cases being 67·2, the same amount as registered in the case of dements of the same age. In females the percentage varies in individual cases from 50 to 70, with an average amount of 61, or 24 per cent. below the normal standard. (7) The average amount of hæmacytes is 86·9 per cent. for men, and 80·4 for women. In no case does the amount reach the normal standard, and in the male series

E. I.—Table of Fifteen Consecutive Male Admissions.

No.	Age.	Weight in lbs.	Duration of Attack.	Mental Disease.	Bodily Health.	Percentage of Hæmoglobin.	Percentage of Hæmacytes.	Proportion of White to Red B. C.
1	40	164	Over a year	Melancholia	Weak	68	89.1	1 to 310
2	58	158	10 weeks	General Paralysis ...	Weak	66	88·4	1 to 260
3	43	154	8 days	Acute Mania	Weak	62	90·9	1 to 180
4	21	112	One month	Mania	Average... ...	60	87·1	1 to 220
5	20	108	Three years	Epileptic Mania	Weak	68	82·4	1 to 350
6	47	140	One week	Mania	Good	70	88·9	1 to 480
7	23	122	One month	Mania	Weak	70	87·6	1 to 320
8	20	112	Two years	Mania	Average... ...	74	90·5	1 to 220
9	52	142	10 days	Mania à potu	Weak	78	90	1 to 280
10	36	151	14 days	General Paralysis	Average... ...	62	88·1	1 to 350
11	32	140	One week	Mania	Good	76	84	1 to 220
12	38	134	Three months ...	Epileptic Mania	Average... ...	68	82·9	1 to 220
13	34	136	Two days	Acute Mania	Average... ...	70	90·9	1 to 320
14	26	128	Two weeks	Epileptic Mania	Average... ...	60	76·9	1 to 200
15	58	150	Four years	Melancholia	Weak	62	86·1	1 to 380
Averages	36·5	136·7				67·2	86·92	1 to 289

E. II.—Table of Fifteen Consecutive Female Admissions.

No.	Age.	Weight in lbs.	Duration of Attack.	Mental disease.	Bodily Health.	Percentage of Hæmoglobin.	Percentage of Hæmacytes.	Proportion of White to Red B. C.
1	21	128	One month	Mania	Average ...	58	78	1 to 200
2	34	90	Two weeks	Melancholia	Weak	50	80·5	1 to 280
3	33	100	Two months ...	Mania	Average ...	65	85·9	1 to 300
4	30	100	One year	Mania	Weak	56	64·2	1 to 360
5	35	112	Three months ...	Melancholia	Average ...	64	76·3	1 to 360
6	41	104	Two weeks	Mania	Average ...	62	77·7	1 to 400
7	63	90	One week	Dementia...	Very feeble ...	62	84	1 to 260
8	31	83	Two years	Melancholia	Very weak ...	60	82·1	1 to 400
9	26	132	Three months ...	Mania	Average ...	70	88·2	1 to 280
10	22	154	Three weeks... ...	Mania	Good	58	76·7	1 to 420
11	27	112	Seven months ...	Melancholia	Average ...	62	82·6	1 to 300
12	37	104	Two years	Melancholia	Average ...	60	86·1	1 to 440
13	50	121	Three days	Mania	Weak	65	79·3	1 to 250
14	52	110	One year	Mania	Weak	60	78·1	1 to 340
15	29	114	One week	Puerperal Mania	Weak	64	86·3	1 to 210
Averages	35·4	110·2				61	80·4	1 to 320

F. I.—Table of Ten Consecutive Male Recoveries.

No.	Age.	Weight.		Period of Residence.	Mental Disease.	Percentage of Hæmoglobin.		Percentage of Hæmacytes.		Proportion of White to Red Corpuscles on Discharge.
		On Admission.	On Discharge.			On Admission.	On Discharge.	On Admission.	On Discharge.	
1	42	160	175	Over 2 months ...	Melancholia ...		82		101·7	1 to 350
2	22	146	161	Over 1 month ...	Acute Mania ...	70	76	90·5	90·9	1 to 190
3	60	166	166	Over 4 months ..	Melancholia ...	62	72	84·7	91·5	1 to 340
4	39	158	164	Over 1 month ..	Mania	70	80	88·8	97·4	1 to 440
5	45	130	150	Over 5 months ...	Mania	70	85	88·9	97	1 to 420
6	27	126	142	Over 19 months ...	Mania		86		92·7	1 to 300
7	75	150	17	Over 3 months ...	Melancholia ...	58	70	75·9	87·9	1 to 440
8	52	142	151	Over 1 month ...	Mania à potu ...	78	84	90	92·1	1 to 360
9	15	101	115	Over 6 months ...	Mania	60	75	77·3	91·3	1 to 320
10	29	164	168	Over 15 months ...	Mania		80		95·7	1 to 280
Averages	40·6	144·3	156·6	5·7 months		*66·8	79·0	*85·1	93·82	1 to 344

* Average of seven observations.

F. II.—Table of Ten Consecutive Female Recoveries.

No.	Age.	Weight.		Period of Residence.	Mental Disease.	Percentage of Hæmoglobin.		Percentage of Hæmacytes.		Proportion of White to Red Corpuscles on Discharge.
		On Admission.	On Discharge.			On Admission.	On Discharge.	On Admission.	On Discharge	
1	21	128	138	Over 3 months ...	Mania	58	80	87·1	94	1 to 220
2	28	93	129	Over 5 months ...	Puerperal Mania	65	78	76·2	91·1	1 to 580
3	30	124	124	Over 6 months ...	Melancholia ...	65	78	87·9	91·5	1 to 340
4	22	106	124	Over 4 months ...	Mania	55	65	81·4	90·2	1 to 280
5	20	126	124	Over 18 months...	Melancholia ...		70		90·9	1 to 240
6	32	134	138	Over 4 months ...	Mania	62	85	81·3	95·5	1 to 210
7	40	126	154	Over 19 months...	Melancholia ...		78		93·1	1 to 320
8	19	92	138	Over 10 months...	Acute Mania ...	58	75	82·7	92·1	1 to 450
9	33	112	114	Over 1 months...	Mania...		80		88	1 to 430
10	50	136	154	Over 8 months ...	Melancholia ..	60	78	80·5	91·6	1 to 220
Averages	29·5	117·7	133·7	8 6 months		*60·4	76	*82·8	91·8	1 to 329

* Average of seven observations

the average is 3 per cent. below that of dements at the same age. (8) The average proportion of white to red corpuscles is increased, especially in the male admissions. In individual instances the fluctuations appear to bear no definite ratio either to the duration of attack or to the mental disease, although, speaking generally, the increase is more obvious when the attack is of short duration, and in the types of mental disease represented by Acute Mania, General Paralysis, and Epilepsy. The individual corpuscles in this series were regular, and, for the most part, uniform in size, though cells of small size were seen in several of the observations. Small granule-cells were seen in less than a third of the cases.

VI.

An examination of the blood of ten consecutive recoveries of either sex, as represented in the foregoing tables (F. I. and F. II.), furnishes us with some interesting and very uniform results :—The average age of the men is more than 10 years over that of the women. With two exceptions, one male who remained stationary and one female who lost 2 lbs., there is a uniform gain in weight in these patients during their residence in the asylum. The average amount gained by men is 12·3 lbs. in 5·7 months; by women 16 lbs. in 8·6 months. Some of the gains in weight are very remarkable, one man gaining 24 lbs. in three months, another 20 lbs. in five months, and a third 15 lbs. in two months, while one woman gained 46 lbs. in nine months, another 36 lbs. in five months, and a third 18 lbs. in four months. In seven cases of either sex the blood was examined on admission, the remaining six cases having been admitted before I commenced the series of observations. Without an exception, the blood in these cases is richer in hæmoglobin and in hæmacytes on discharge than when the patients were admitted. In males the average percentage of hæmoglobin on admission is 66·8, that of these seven cases on discharge 77·4, while the average for the ten cases is 79. The average percentage of hæmacytes is 85·1 on admission, that of the seven cases on discharge 92·4, while the average of the ten cases is 93·82. In females the respective percentages are hæmoglobin 60·4 on admission; 77 for seven cases and 76·7 for ten cases on discharge; hæmacytes 82·8 on admission, 92·2 for seven cases and 91·8 for ten cases on discharge. We thus see that there is an individual and a collective gain in the richness of the blood among patients

who recover. The improvement is more noticeable, and the percentages of hæmoglobin and hæmacytes approach more nearly the normal standard, in the case of female recoveries than in those of males. In neither sex does the period of residence or the type of mental disease appear to affect the quality of the blood in any uniform ratio.

The proportion of white to red corpuscles is rather higher than normal, the average being 1 to 344 in men and 1 to 329 in women. The individual corpuscles were regular in outline, and large and small cells were observed with greater frequency than in normal blood. Small forms especially were numerous. Clusters of hæmatoblasts were seen in all the cases.

Of the 20 patients, eight men and seven women had tonic treatment. The average per cent. of hæmoglobin in these 15 cases was 80 for men, 76·8 for women; the average percentage of hæmacytes, men 94·5, women 92·3. In other words the blood showed greater improvement in those who had undergone a course of tonics than in those who had no medical treatment.

VII.

The influence of tonics on the quality of the blood of patients during the early period of residence in asylums is an interesting and important study. I hope on some future occasion, after making a sufficient number of observations, to treat this subject at greater length than I am able to do at present.

The following remarks are based on a series of 130 observations on 22 individuals—15 men and seven women. The number of observations on individual cases varied from three to ten, and the period of time represented by each series from six weeks to eleven months. Of the 22 cases, eight have recovered, six are convalescing, one has died, and seven have not improved. Tonic treatment was administered to the patients on ordinary general principles, and their blood was examined while they were undergoing the particular line of treatment. By this I mean that the patients were not selected and then given special treatment with the view of collecting data for this enquiry.

For the sake of comparison, I examined the blood of three patients who were not receiving any tonic treatment; these represent 20 of the 130 observations. One case was treated with cod-liver oil, extract of malt, and quassia respectively, two with arsenic, three with iron, seven with iron and quinine, and four with a combination of iron, quinine, and strychnia.

The ages ranged from 16 to 62 years. The only remark

which calls for comment under this head is that the improvement in the quality of the blood was more pronounced in the young, and in those advanced in years, than in the middle-aged. In the aggregate the 22 patients gained 179 lbs in 78 months, or an average of 8·1 lb. in 3·5 months ; 18 gained an aggregate of 188 lbs., three lost an aggregate of 9 lbs., and one remained stationary. The average percentage of hæmoglobin in the first observations on each individual, *i.e.*, before the treatment was commenced, was 61 ; in the last observations, or when the treatment was discontinued, 70. In 18 cases there was a definite increase varying from six to twenty per cent., in two a diminution—eight per cent. in one case, nine per cent. in the other; while two cases did not vary. The average amount of hæmacytes was 81·1 for the first observation, 89·2 for the last. The percentage was increased in twenty cases, the gain fluctuating between 1·9 the lowest and 26·3 the highest amount gained. In two cases there was loss, but in neither instance did this exceed two per cent. The proportion of white to red corpuscles showed considerable variations, but not in any definite direction. The average of the first observation was 1 to 384, of the last 1 to 320. Hæmatoblasts were seen in nearly all of the observations, the exceptions being the first observation in three cases, and the last observation in the individual who died. Many of the red-blood corpuscles throughout the series were of smaller size than normal, and in addition were feebly coloured. In no case did the blood show any marked deterioration after the tonic treatment was discontinued.

The cases which had no medical treatment, and those treated with cod-liver oil and a bitter tonic (quassia), differed from the rest of the series in that there were considerable fluctuations in the quality of the blood at the different periods. In the instances where an increase in the amount of hæmoglobin and hæmacytes was recorded this did not take place uniformly, and the total increase did not amount to 10 per cent. in either case. On the other hand the blood of those in whom iron, either alone or in combination, formed part of the treatment, varied in a definite and particular way. For the first fortnight the hæmoglobin remained stationary, while the amount of hæmacytes was largely increased. In the third and fourth weeks the hæmoglobin continued stationary and the hæmacytes were diminished. During the second month the hæmoglobin was slightly increased in all the cases, while the percentage of hæmacytes increased in the patients progressing towards mental recovery, but diminished in the others. In each instance improvement in the amount of hæmacytes preceded

the increase in the percentage of hæmoglobin. The greatest increase was observed in the cases treated with iron, quinine, and strychnia, next in those treated with iron and quinine, and a less though quite a definite improvement in quality in those treated with iron alone. The blood in the two patients treated for two months with arsenic showed slight variation in the quantity of hæmoglobin and hæmacytes; in both cases the treatment was changed to iron and quassia when a definite improvement took place. Considerable improvement was observed in the case treated with extract of malt. The increase in the amount of the hæmoglobin and hæmacytes was gradual and progressive, and, as in the cases where iron was given, the blood improved in hæmacytes before the percentage of hæmoglobin was much increased. In every instance where there was a marked increase in weight the quality of the blood improved. While this improvement was more noticeable in cases which improved, or were mentally convalescing, it also occurred to some extent in the others.

I have not sufficient data to discuss the effect of mental relapses and maniacal outbursts in these cases, and I regret that the limits of the paper prevent my giving the whole series of observations in tabular form. The influence of large and small doses of the various tonics on cases of recent admission must be omitted for similar reasons. Indeed I feel diffident in attempting to discuss the subject of blood-tonics in a fragmentary form before my observations have been completed, and my only excuse is that the paper should contain at least an introduction to this, the practical outcome of the whole subject. The observations I have made so far are encouraging, and sufficiently uniform to enable one to anticipate valuable and accurate results if this method of clinical research is persevered in, and engages the attention of several observers.

VIII.

Summary.—I have endeavoured to approach the subject from an unbiassed and scientific standpoint, to avoid theorising and to arrive at my deductions only from observed facts. Each series of observations has been summed up and commented on separately, but the following general conclusions seem warranted :—

(1.) While there is no evidence to show that anæmia in itself is a cause of insanity, yet an anæmic condition of the blood is undoubtedly in many cases intimately associated with mental disease.

(2.) The blood in the demented class of asylum patients is

deficient in hæmoglobin and in hæmacytes, and the deterioration progresses as age advances.

(3.) The blood in patients known to be addicted to masturbation is deteriorated in a marked degree.

(4.) The blood is below the normal standard in General Paralysis, and the deficiency is greater in the active and completely paralysed stages of the disease than in the intervening periods of inactivity and quiescence.

(5.) While there is a deficiency in the quality of the blood in Epileptics, the decrease is not so pronounced as in ordinary dements at the same age.

(6.) Prolonged and continuous doses of Bromide of Potassium do not cause deterioration in the quality of the blood.

(7.) Prolonged attacks of excitement have a deteriorating influence on the quality of the blood.

(8.) The blood of the average number of patients on admission is considerably below the normal standard.

(9.) In patients who recover, the quality of their blood improves during residence in the asylum, and on discharge is not much below the normal standard.

(10.) There appears to be a close connection between gain in weight, improvement in the quality of the blood, and mental recovery.

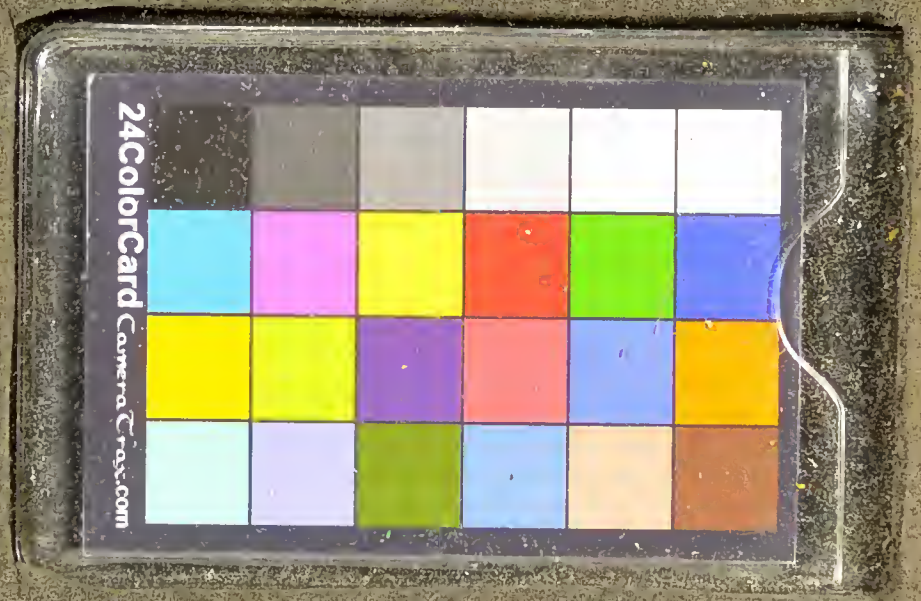
(11.) While there is a definite improvement in the condition of the blood during mental convalescence in all cases, the improvement is both more pronounced and more rapid in those who have had tonic treatment.

(12.) The four tonics which either alone or in combination proved most efficacious in restoring the quality of the blood as shown by these observations may be classed in order of value thus (*a*) iron, quinine and strychnia (*b*) iron and quinine (*c*) iron alone (*d*) malt extract.

(13.) Arsenic proved of little value as a blood tonic in these cases, and the observations with quassia and cod-liver oil did not give satisfactory results.

(14.) The close connection which exists between improvement in the quality of the blood, increase in weight, and mental recovery, the converse which exists in cases of persistent and incurable dementia, and the marked improvement which is effected by certain remedial agents, show that this line of clinical research, more especially with reference to the curative treatment of the insane, should have more attention paid to it than has hitherto been the case.

IRREGULAR NUMBERING DUE
TO MANY PAMPHLETS
BOUND TOGETHER.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